

1 (9) CLAIMS

2 1. Connected to an output pad of an integrated circuit, an output driver circuit device,  
3 having a predetermined power supply voltage nominal level, the device comprising:  
4       a MOSFET first stage including a means for amplifying an input signal and an  
5 means for outputting an output signal state; and  
6       a BiCMOSFET second stage including means for automatically maintaining said  
7 output signal at the output signal state when said power supply voltage nominal level is less  
8 than a threshold voltage required for said MOSFET first stage to maintain said output signal  
9 state.

10 2. The device as set forth in claim 1 wherein said second stage includes BiCMOSFET  
11 components for maintaining said output signal state at a digital logic LOW.

12 3. The device as set forth in claim 2, comprising:  
13       said second stage providing a substantial amount of sink current such that said  
14 output signal is said digital logic LOW even when the power supply voltage falls lower than  
15 said nominal level.

16 4. The device as set forth in claim 1 wherein said second stage includes BiCMOSFET  
17 components for maintaining said output signal state at a digital HIGH.

1       5.     The device as set forth in claim 4, comprising:

2               said second stage providing a substantial amount of source current such that said  
3               output signal is said digital logic HIGH even when the power supply voltage falls lower than  
4               said nominal level.

5       6.     The device as set forth in claim 1 wherein said second stage is a BiCMOSFET  
6               auxiliary output driver maintained in a desired state when said power supply voltage  
7               nominal level is substantially equal to but no less than said threshold voltage.

8       7.     The device as set forth in claim 6 wherein threshold voltage of an output driving  
9               connected MOSFET of said BiCMOSFET auxiliary output driver is substantially equivalent  
10               to threshold voltage of an output driving MOSFET of said first stage.

11      8.     The device as set forth in claim 6 further comprising:

12               means for preventing leakage current in bipolar components from turning said  
13               BiCMOSFET auxiliary output driver to an ON state when said power supply voltage nominal  
14               level is within design criteria operating range.

15      9.     The device as set forth in claim 1 further comprising:

16               said second stage including means for protecting said second stage from  
17               electrostatic discharge into power supply nodes.

1        10. The device as set forth in claim 1 wherein maximum amount of drive to said output  
2        pad is determined by respective gains of bipolar transistors of said BiCMOSFET second  
3        stage and resistance value of a bias resistor therefor.

4        11. An auxiliary output signal driver device for a CMOS output driver circuit for an output  
5        pad of an integrated circuit, having a given power supply voltage having an operating range  
6        wherein said operating range maintains threshold voltage for MOSFET components of said  
7        output driver circuit, said auxiliary output signal driver device comprising:

8                coupled to said output pad, an output node from a series of bipolar transistors, said  
9        bipolar transistors having a predetermined bias resistor for determining current flow thereto;  
10        and

11                connected to said bias resistor, a MOS transistor for shunting a current that passes  
12        through said bias resistor, such that when said power supply voltage is substantially within  
13        said operating range the MOS transistor prevents the current from driving a base of a first  
14        bipolar transistor of said series, and when said power supply is below said operating range  
15        the MOS transistor is not shunting the current that passes through said bias resistor and the  
16        current is thereby driving the base of the first bipolar transistor of said series.

17        12. The device as set forth in claim 11 wherein when said MOS transistor is driving the  
18        current, said device is providing a substantial amount of sink current such that said output  
19        signal is said digital logic LOW even when the power supply voltage falls below said  
20        operating range.

1        13.     The device as set forth in claim 11 wherein when said MOS transistor is driving  
2           current, said device is providing a substantial amount of source current such that said  
3           output signal is said digital logic HIGH even when the power supply voltage falls below said  
4           operating range.

5        14.     The device as set forth in claim 11 wherein threshold voltage of an output driving  
6           connected MOSFET of said BiCMOSFET auxiliary output driver is substantially equivalent  
7           to threshold voltage of an output driving MOSFET of said first stage.

8        15.     A output driver circuit for an integrated circuit having a  $V_{DD}$  power supply operating  
9           range, the circuit comprising:

10                MOSFET means for amplifying an input signal to said output driver circuit such that  
11                a digital signal state level is output therefrom; and

12                coupled to said means for amplifying, BiCMOS means for maintaining the digital  
13                signal state level output by said circuit when  $V_{DD}$  power supply voltage falls beneath said  
14                 $V_{DD}$  power supply voltage operating range, wherein said BiCMOS means for maintaining is  
15                inactive when said  $V_{DD}$  power supply voltage is within said  $V_{DD}$  power supply voltage  
16                operating range.